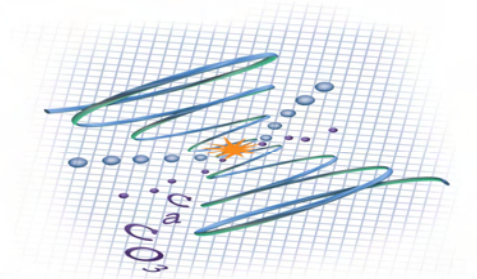
Non-Chemical Water Treatment

VRTX Technologies
800-722-0476
vrtx@vrtxtech.com

www.vrtx-technologies.com



VRTX Technology

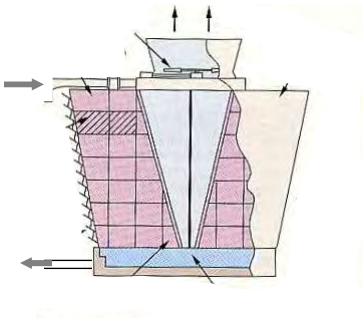
- Cooling System Review
- Introduction of Technology
- VRTX Awards/Case Histories

Cooling Water Systems

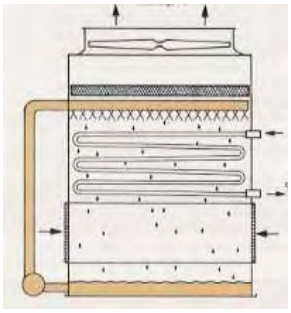
Cooling Tower

Evaporative Condenser

Air Flow Patterns



Cooling Tower

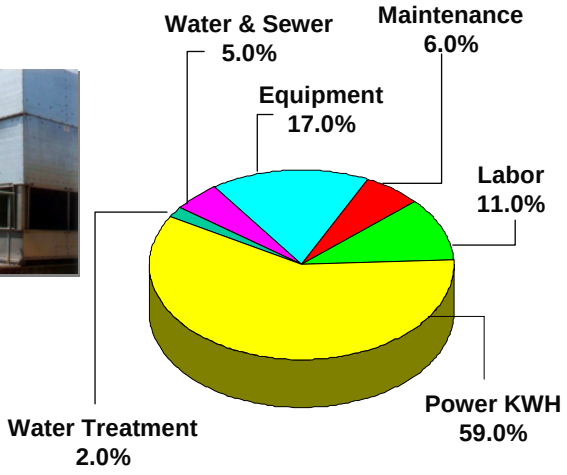


Condenser

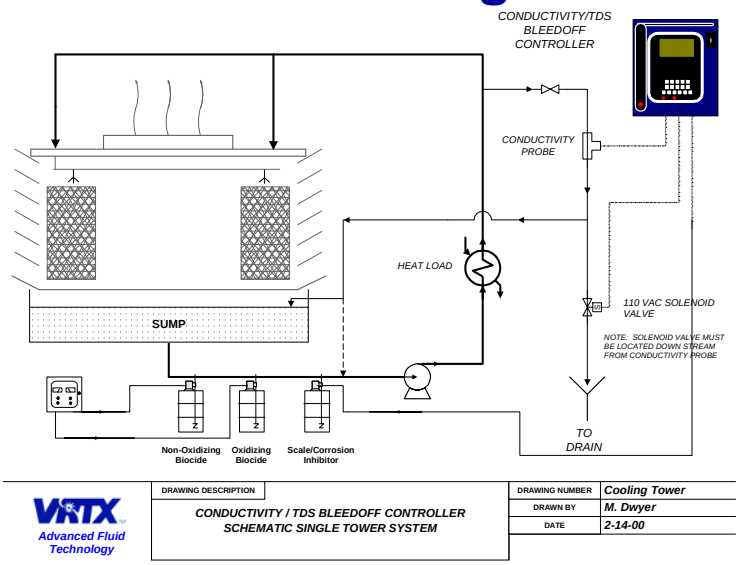
Problems Related to Cooling Water Treatment

PROBLEMS	EFFECTS
Scale	■ Increased maintenance cost
Corrosion	■ Reduced heat transfer efficiency
Bacteria	■ Increased energy cost
	■ Increased water costs
	■ Increased sewage costs
	■ Increased safety and training issues
	■ Reduced plant efficiency
	■ Reduced equipment life
	■ Growth of hazardous micro organisms

Cooling System Operational Costs

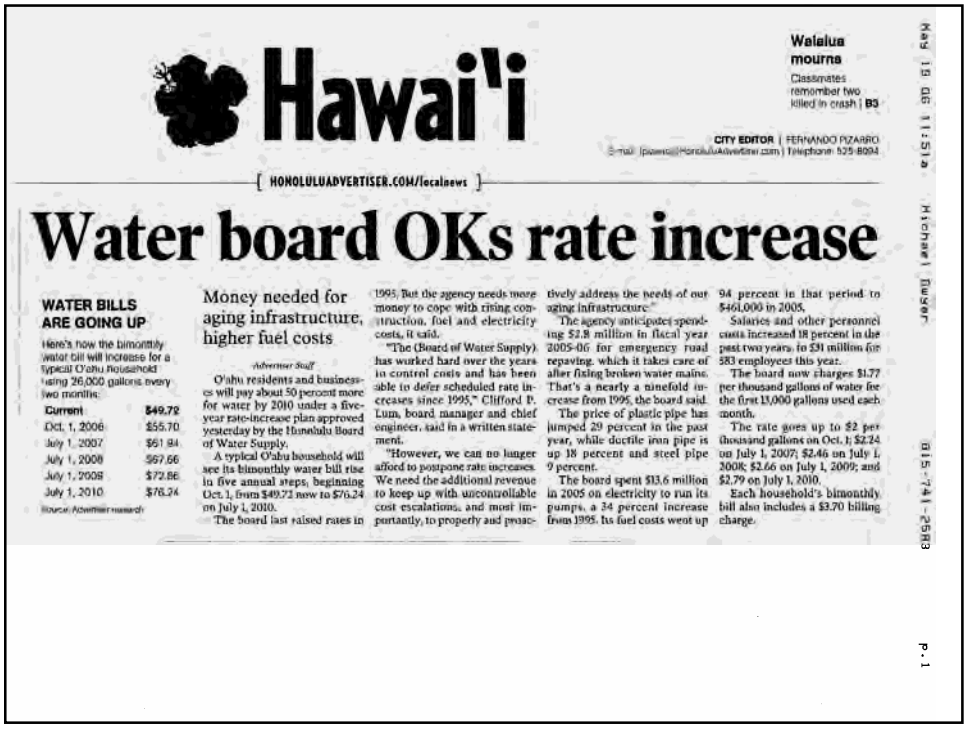


Typical Cooling Water Chemical Treatment Program



Conventional Chemical Solution

- Chemical solution requires constant adjustments, daily additions of chemicals and costly system blow-downs
- Chemical treatment costs range from $500 to $1,000 per month for 1,000 ton tower
  - Water is typically cycled only 2.0x to 3.0x before it is discharged (blow-down)
  - Blow-down is a major source of discharge streams and a source of pollution
- Water and sewer costs are projected to increase by 10% to 40% per year
- Chemical Treatment costs have risen 7-10% per year for the past 3 years; with no end in site



Hawai'i

Waialua mourns
Classmates remember two killed in crash | B3

CITY EDITOR | FERNANDO PIZARRO
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[HONOLULUADVERTISER.COM/localnews]

Water board OKs rate increase

WATER BILLS ARE GOING UP

Here's how the bimonthly water bill will increase for a typical O'ahu household using 26,000 gallons every two months:

Current	**$49.72**
Oct. 1, 2006	$55.70
July 1, 2007	$61.84
July 1, 2008	$67.66
July 1, 2009	$72.86
July 1, 2010	$76.24

Source: Advertiser research

Money needed for aging infrastructure, higher fuel costs

Advertiser Staff

O'ahu residents and businesses will pay about 50 percent more for water by 2010 under a five-year rate-increase plan approved yesterday by the Honolulu Board of Water Supply.

A typical O'ahu household will see its bimonthly water bill rise in five annual steps, beginning Oct. 1, from $49.72 now to $76.24 on July 1, 2010.

The board last raised rates in 1995. But the agency needs more money to cope with rising construction, fuel and electricity costs, it said.

"The (Board of Water Supply) has worked hard over the years to control costs and has been able to defer scheduled rate increases since 1995," Clifford P. Lum, board manager and chief engineer, said in a written statement.

"However, we can no longer afford to postpone rate increases. We need the additional revenue to keep up with uncontrollable cost escalations, and most importantly, to properly and proactively address the needs of our aging infrastructure."

The agency anticipates spending $2.8 million in fiscal year 2005-06 for emergency road repaving, which it takes care of after fixing broken water mains. That's a nearly a ninefold increase from 1995, the board said.

The price of plastic pipe has jumped 29 percent in the past year, while ductile iron pipe is up 18 percent and steel pipe 9 percent.

The board spent $13.6 million in 2005 on electricity to run its pumps, a 34 percent increase from 1995. Its fuel costs went up 94 percent in that period to $461,000 in 2005.

Salaries and other personnel costs increased 18 percent in the past two years, to $31 million for 383 employees this year.

The board now charges $1.77 per thousand gallons of water for the first 13,000 gallons used each month.

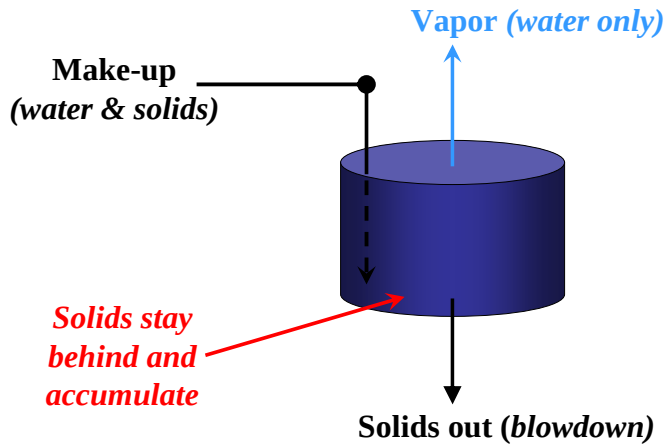
The rate goes up to $2 per thousand gallons on Oct. 1; $2.24 on July 1, 2007; $2.46 on July 1, 2008; $2.66 on July 1, 2009; and $2.79 on July 1, 2010.

Each household's bimonthly bill also includes a $3.70 billing charge.

May 19 06 11:51a Michael Burger 815-741-2583 p.1

Evaporation…

How Evaporation Works…



Cycles of Concentration…

Water can be monitored so that critical threshold limits are not exceeded. We refer to that limit by the term: *"Cycles of Concentration"*.

Simply stated, this is the number of uses you get out of your water before you discharge it.

Example…

Water Source:	*Chlorides:*
Make-up	70 mg/l
Cooling Water	350 mg/l

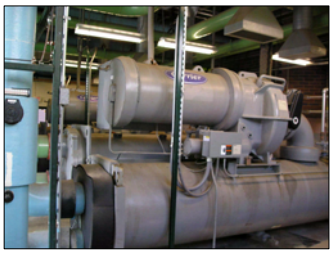
$$\text{Cycles} = \frac{350}{70} = 5$$

VRTX

Plant Engineering PRODUCT of the YEAR 1999

VRTX Technology

Introduction to Non-Chemical Cooling Water Treatment

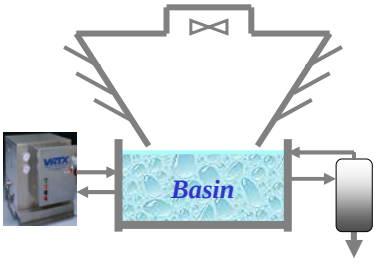


VRTX Technology

- Patented
- Award winning
- Field-test proven
- Mechanical
- Side-stream treatment
- VRTX unit / filtration unit

VRTX Technology - *How It Works*

- ***VRTX unit and filtration system operate independently***
- ***Both withdraw and return water to sump***
- ***VRTX unit converts dissolved calcium into calcium carbonate colloids, kills bacteria, and removes corrosive gases from water***
- ***Filter system removes suspended solids from recirculating water***

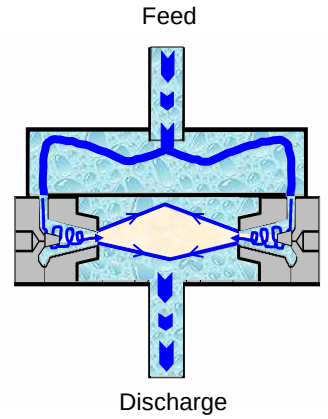


VRTX Cavitation Technology

How Does VRTX Generate Cavitation?

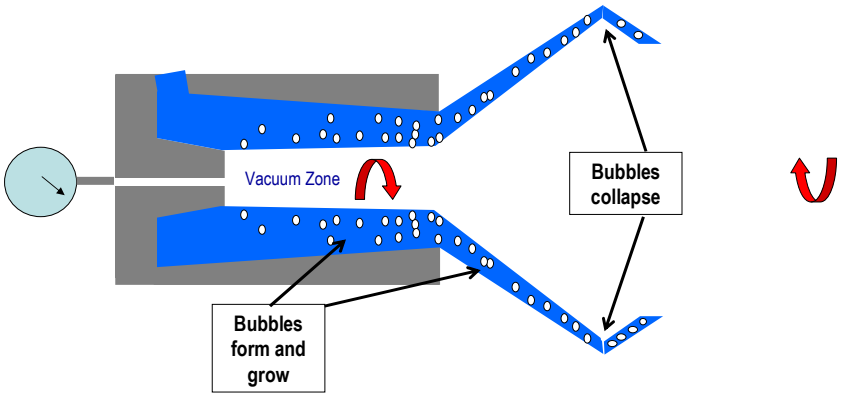
Mechanical device causes significant changes in static pressure in flowing fluid:

- **Vacuum condition is optimum for the formation and growth of bubbles**
- **Two opposite streams collide at the mid-point of chamber (no erosion to nozzle/chamber)**



VRTX Cavitation Technology

Fluid Flow Inside of VRTX Nozzle



VRTX Technology

System Description

System Components

- ***VRTX Unit:***
  VRTX chamber, pump
- ***Filtration system***
- ***Suction Strainers***
- ***Blow-down control system***

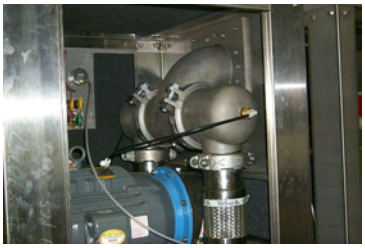
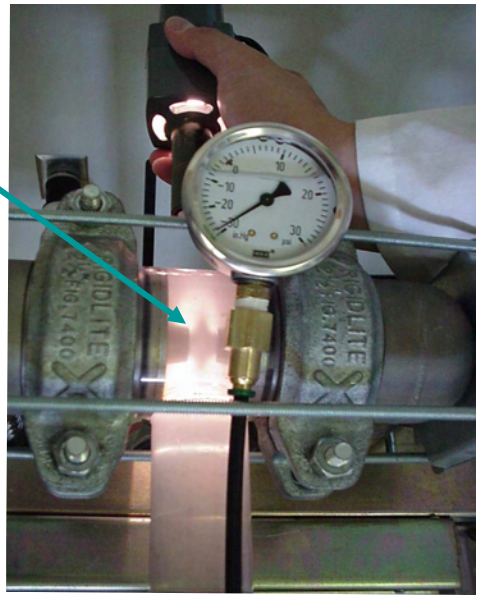


Photo of VRTX Hyper Kinetic Zone

HDC
"Hyper-Kinetic" Zone



VRTX Technology - *How It Works*

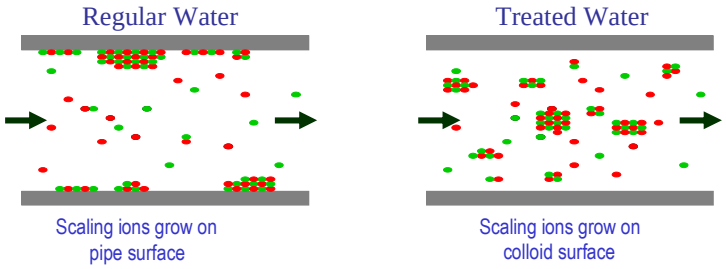
Chemical reactions

- ***Operating conditions force the dissolved calcium and carbonate ions to react and form colloidal, calcium carbonate crystals***
  - $Ca(HCO_3)_2$ solution $\xrightarrow{\sim}$ $CaCO_3 + H_2O + CO_2$ suspension
- ***Strong vacuum strips CO_2 gas from water and shifts chemical equilibrium to the right***
- ***Hydrodynamic cavitation creates extremely high temperature zone; and the solubility of $CaCO_3$ is decreased***
- ***Dissolved calcium and carbonate ions are dehydrated and combine to form $CaCO_3$***

VRTX Technology - *How It Works*

Chemical reactions

- ***$CaCO_3$ colloids act as incubation sites for dissolved calcium and carbonate ions to grow on***
- ***$CaCO_3$ colloidal crystal growth is thermo-dynamically favored over precipitation on equipment surfaces***

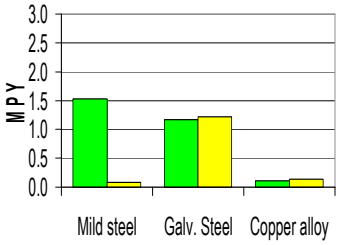


VRTX Technology - *How It Works*

Corrosion Control

- ***Maintaining water at high pH levels (pH > 8.5)***
- ***Removing corrosive dissolved gases***
- ***Controlling bacterial activity***
- ***Eliminating corrosive chemicals***
- ***Reducing suspended solids***

Days Exposed: 179

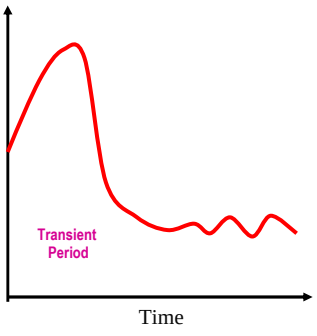


Days Exposed: 127

Bacterial Control

How It Works

- **Physically ruptures cell wall membranes**
  - ✓ **Dramatic changes in pressure and vacuum**
  - ✓ **Shear and collision forces created by the collision of water streams**
  - ✓ **High temperature and sonic wave produced by hydrodynamic cavitation**
- **A cumulative effect observed in various installations**

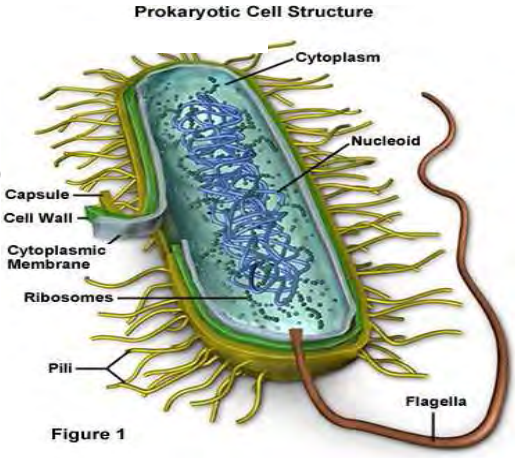


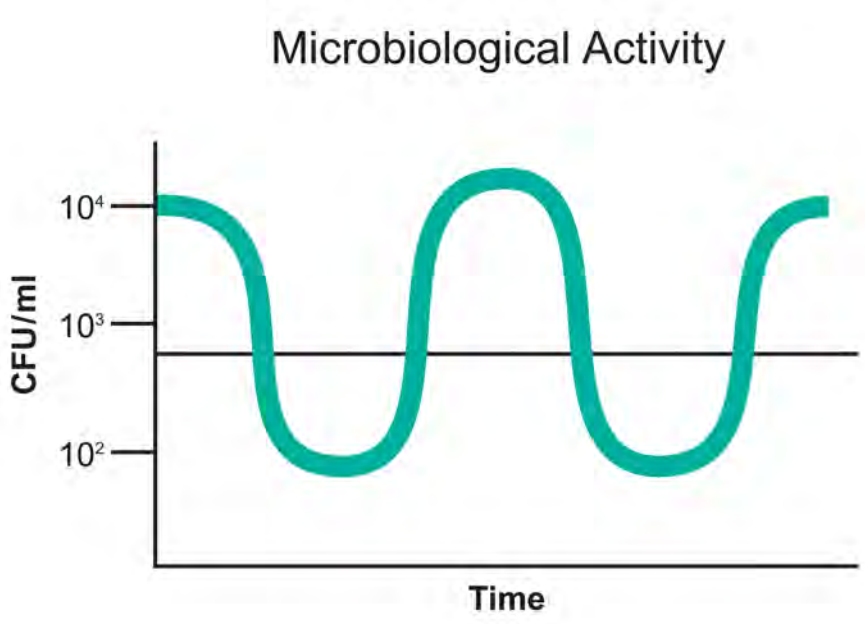
Bacteria

VRTX Treatment:

How it works ?

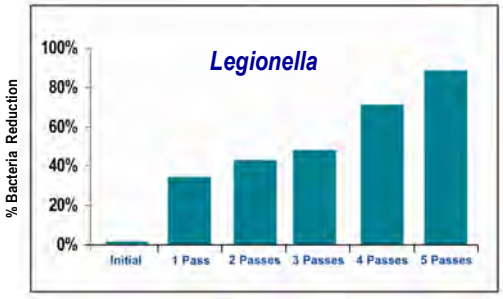
- ***Physical damage***





Legionella Control

Lab Test Results on Bacteria Kill

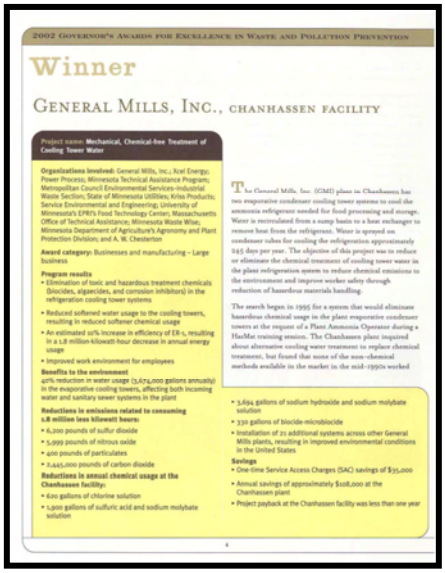


VRTX System with ZGF Filtration

VRTX Technology

- Awards/Recognition
- VRTX Case Histories

Plant Engineering
Gold Medal Award Winner
February, 1999



2002 Governor's Awards for Excellence in Waste and Pollution Prevention

Winner

General Mills, Inc., Chanhassen Facility

Project name: Mechanical, Chemical-free Treatment of Cooling Tower Water

Organizations involved: General Mills, Inc.; Xcel Energy; Power Process; Minnesota Technical Assistance Program; Metropolitan Council Environmental Services–Industrial Waste Section; State of Minnesota Utilities; Kriss Products; Service Environmental and Engineering; University of Minnesota's EPRI's Food Technology Center; Massachusetts Office of Technical Assistance; Minnesota Waste Wise; Minnesota Department of Agriculture's Agronomy and Plant Protection Division; and A. M. Chesterton

Award category: Businesses and manufacturing – Large business

Program results
- Elimination of toxic and hazardous treatment chemicals (biocides, algaecides, and corrosion inhibitors) in the refrigeration cooling tower systems
- Reduced softened water usage to the cooling towers, resulting in reduced softener chemical usage
- An estimated 10% increase in efficiency of ER-1, resulting in a 1.8 million-kilowatt-hour decrease in annual energy usage
- Improved work environment for employees

Benefits to the environment
40% reduction in water usage (3,674,000 gallons annually) in the evaporative cooling towers, affecting both incoming water and sanitary sewer systems in the plant

Reductions in emissions related to consuming 1.8 million less kilowatt hours:
- 6,200 pounds of sulfur dioxide
- 5,999 pounds of nitrous oxide
- 400 pounds of particulates
- 7,445,000 pounds of carbon dioxide

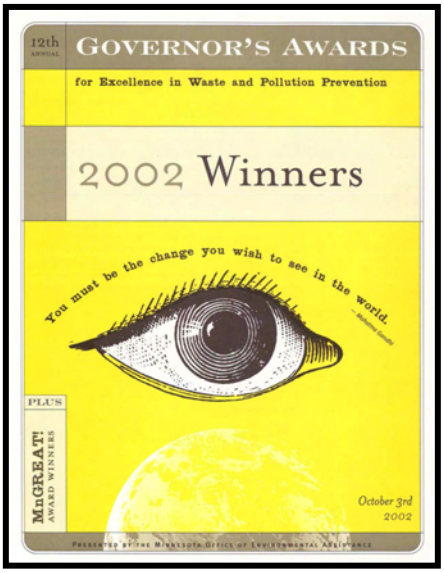
Reductions in annual chemical usage at the Chanhassen facility:
- 620 gallons of chlorine solution
- 1,500 gallons of sulfuric acid and sodium molybate solution

The General Mills, Inc. (GMI) plant in Chanhassen has two evaporative condenser cooling tower systems to cool the ammonia refrigerant needed for food processing and storage. Water is recirculated from a sump basin to a heat exchanger to remove heat from the refrigerant. Water is sprayed on condenser tubes for cooling the refrigeration approximately 225 days per year. The objective of this project was to reduce or eliminate the chemical treatment of cooling tower water in the plant refrigeration system to reduce chemical emissions to the environment and improve worker safety through reduction of hazardous materials handling.

The search began in 1995 for a system that would eliminate hazardous chemical usage in the plant evaporative condenser towers at the request of a Plant Ammonia Operator during a HazMat training session. The Chanhassen plant inquired about alternative cooling water treatment to replace chemical treatment, but found that none of the non-chemical methods available in the market in the mid-1990s worked

- 3,694 gallons of sodium hydroxide and sodium molybate solution
- 330 gallons of biocide-microbiocide
- Installation of 21 additional systems across other General Mills plants, resulting in improved environmental conditions in the United States

Savings
- One-time Service Access Charges (SAC) savings of $35,000
- Annual savings of approximately $108,000 at the Chanhassen plant
- Project payback at the Chanhassen facility was less than one year



NREP

2005

National Registry
of Environmental Professionals

Environmental Award

Water, Wastewater, Storm Water Category

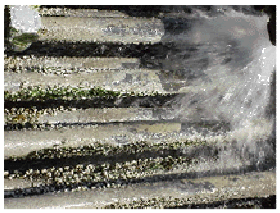
2006 AHR Expo
Innovation Award Winner

Most Innovative Product
Green Building Category

VRTX Technology – *Case History*
Food Processor

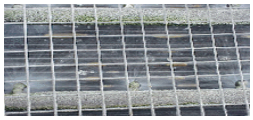
Chemical Treatment

- Softened water used as makeup
- Chemical treatment at a cost of $22K / yr
- Scale on condenser tubes 3/8 inches and in basin
- Bacteria counts 50,000 – 75,000 CFU / ml
- Cycles of concentration at 3.0
- Discolored water



VRTX Treatment

- Raw city water used as makeup
- Hard scale significantly reduce
- Bacteria counts 5,000 – 10,000 CFU/ml
- Corrosion 1.8 - 2.4 mpy for mild steel
- Cycles of concentration = 8
- Annual water savings 4.8 million gallons
- Makeup savings > 30%
- Blow-down reduction >70%



Leadership in Energy & Environmental Design *LEED* Certification

US Green Building Council

- ***HDC Technology will give significant advantage toward* LEED *Goal Achievement and Advancement for buildings in pursuit of* LEED.**
- ***VRTX Awarded 2006 AHR Innovation Award in "Green Buildings" Category***

Summary

- ***VRTX System offers a complete solution to cooling water problems – controlling all three problems simultaneously***
- ***Successful treatment of cooling waters with wide range of water chemistries***
- ***Environmentally friendly***
- ***Blowdown reuse option***
- ***Significant reduction in water consumption***
  Blowdown reductions of 40-60% and 15-30% reduction of makeup common at numerous installations
- ***ROI's range from 12 months to 42 months***

Hotel – Honolulu, HI

SUMMARY OF KEY POINTS

Application: Two 80 gpm VRTX Units with Two 250 gpm Bag Filter Systems

Purchase Option:

Purchase Price	$ 85,000
Gross Savings (Estimate)	**$107,201/Year**
Net Operating Savings (Estimate)	**$ 99,751/Year**
Simple Payback	**16 Months***

* Simple payback includes estimated installation cost of $43,000.00. This cost may vary, depending upon final site inspection and method of installation.

Monthly Management Option:

Full Service Agreement	$3,665/ Month*
Gross Savings (Estimate)	**$8,312/Month**
Net Savings (Estimate)	**$4,647/Month**

* This includes the estimated installation cost of $43,000.00.

Hotel Benefits

- **Annual water savings of over 14,000,000 gallons**
- **Ability to reuse over 5 million gallons of non-potable water for applications at your discretion**
- **No chemicals to be handled by employees**
- **No drum disposal or chemical testing issues**
- **No Sara Title III to be reported**
- **No Purchase orders for chemicals or reagents**
- **Internal Rate of Return of 77%**
- **No price increases guaranteed for 3 years**
- **Same or better results for scale, corrosion, and microbiological control**


Discussion